
Fagopyrum wenchuanense and *Fagopyrum qiangcai*, Two New Species of Polygonaceae from Sichuan, China

Ji-Rong Shao,¹ Mei-Liang Zhou,¹ Xue-Mei Zhu,^{2*} De-Zhou Wang,¹ and Da-Quan Bai¹

¹School of Life Sciences, Sichuan Agricultural University, Yaan, Sichuan, 625014, People's Republic of China

²School of Resources and Environment, Sichuan Agricultural University, Yaan, Sichuan, 625014, People's Republic of China

*Authors for correspondence: zhml39@yahoo.cn, shaojr007@163.com

ABSTRACT. *Fagopyrum qiangcai* D. Q. Bai and *F. wenchuanense* J. R. Shao, two new species of Polygonaceae from Wenchuan County, Sichuan Province, China, are described and illustrated. *Fagopyrum qiangcai* is closely related to *F. esculentum* Moench based on its leafy base, triangular leaves, and terminal or axillary racemes. The new species differs in having congested nodes at the base of the plant, triangular to oval terminal leaves with bright red veins, dense inflorescences, white punctate adaxial leaf surfaces, and an articulate pedicel. *Fagopyrum qiangcai* is diploid, $2n = 2x = 16$, with a karyotype of 12 metacentric and four submetacentric chromosomes. *Fagopyrum wenchuanense* is closely related to *F. gracilipes* (Hemsl.) Dammer ex Diels but differs in its caespitose habit, the plants often with prostrate stems. Its leaves vary from broadly cordate to ovate to hastate or long hastate, the pedicels are basally puberulent, the stamens and pistils are variable in length, and the capsules are ellipsoid-triangular or broadly ovoid-triangular, $3\text{--}3.5 \times 2.5\text{--}3$ mm. *Fagopyrum wenchuanense* is diploid, $2n = 2x = 16$, with a karyotype of 16 metacentric chromosomes.

Key words: China, *Fagopyrum*, IUCN Red List, Polygonaceae, Sichuan.

Buckwheat belongs to the Old World genus *Fagopyrum* Mill. (Polygonaceae). It is an annual herbaceous plant with origins in China and Central Asia; it is most diverse in China, where 10 of its 16 species are found (Li, 1998; Ohnishi, 1998). In southern China, buckwheat is an important crop that provides security to traditional farmers under subsistence farming practices. Owing to its frost resistance, short growth period, and undemanding cultivation, buckwheat is common in high-altitude areas at ca. 2000 m, and in Tibet it is found at elevations of up to 4500 m (Wang, 1989; Ohnishi & Yasui, 1998). Ohnishi (1998) reported that the cultivated common buckwheat originated in the region from southwestern China to the Himalayas. In July 2006, we found two

new species of wild-type buckwheat, here described as *F. qiangcai* D. Q. Bai and *F. wenchuanense* J. R. Shao, in Wenchuan County, Aba Prefecture, Sichuan Province, China. In this paper, we discuss the morphological characteristics and karyotypes of these new species and their relationships to existing species.

MATERIALS AND METHODS

Species of the two new buckwheat taxa were collected in July 2006 and cultivated at Sichuan Agricultural University. Selected seeds were soaked in distilled water and germinated at 25°C for 24 hr. until root tips were 1–2 cm long. Primary roots were pretreated in ice water for 27 hr., fixed for 24 hr. in 3:1 glacial acetic acid:ethanol solution, rinsed with distilled water, and hydrolyzed in 1 mol/L HCl at 25°C for 8–15 min. After rinsing, the root tips were squashed in phenol rosaniline, and five well-scattered metaphase plates of each genotype were selected for karyotype analysis. Karyotype averages were calculated using the method described by Li and Chen (1985); the chromatid classification was determined according to Stebbins (1971).

TAXONOMIC RESULTS

1. *Fagopyrum qiangcai* D. Q. Bai, sp. nov. TYPE: China. Sichuan: Aba State, KeKu town, in thick growth of grass on slopes, 1580 m, 16 July 2006, J. R. Shao & D. Q. Bai Ghassot 4396 (holotype, SAU). Figure 1.

Haec species basi foliata, foliis sagittatis et racemis axillaribus vel terminalibus *Fagopyro esculento* Moench similis, sed ab eo nodis congestis prope plantae basin, foliis albo-maculatis nervis phoeniceis, pedicello articulado et inflorescentia densa non interrupta differt.

Plants annual, herbaceous, 15–45 cm, with dense, short internodes at or near the base of the plant,

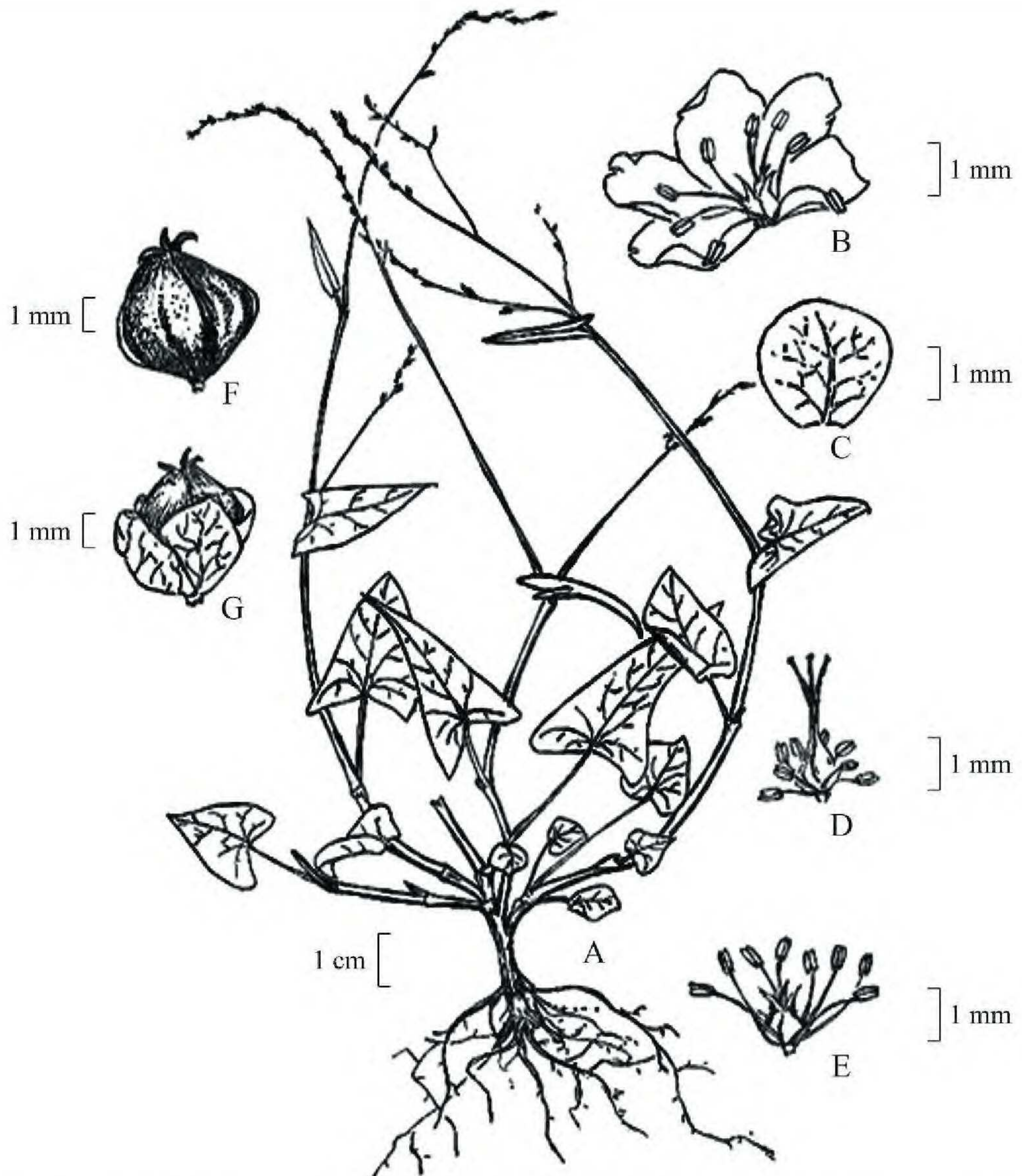


Figure 1. *Fagopyrum qiangcai* D. Q. Bai. —A. Plant habit. —B. Intact flower. —C. Perianth segment. —D. Long-styled flower, with the perianth removed. —E. Short-styled flower, with the perianth removed. —F. Achene, with the perianth removed. —G. Achene enveloped by the persistent perianth. A–F drawn by D. Yan from the holotype, J. R. Shao & D. Q. Bai Ghassot 4396 (SAU).

multi-branching; stems erect, pinkish red in color, terete, with a number of longitudinal ribs. Leaves simple, alternate, sagittate, green or gray-green with white spots on the adaxial surface, with 5 to 7 pairs of basal nerves and (4)5 to 7 pairs of lateral nerves, bright red on young leaves; petioles on basal and cauline leaves (0.5–)1.2–1.5(–4) cm, reddish brown or brown-green, slightly grooved longitudinally; terminal leaves sessile, papery, triangular to oval, (0.8–)1.2–4(–4.6) × (0.8–)1.2–4.5(–5.1) cm, apex

acuminate, base truncate or retusely truncate; ocreae thick-membranous, obliquely tubular, 5–9 mm, with 9 to 15 green longitudinal veins, apex acuminate to caudate. Inflorescence racemose, terminal or extra-axillary, sometimes a panicle, 1–10 cm, axis cylindrical, red to reddish brown; flowers densely packed on axis at intervals of (0.1–)0.12–1.4 cm; bracts obliquely funnel-shaped, 2–3 mm, with 3 prominent green veins, the central vein coarse, projecting above bract as an awn. Flowers bisexual,

heterostylous, perianth segments 5, obovate to ovate, 3–5 mm, iridescent, pink; stamens 8, anthers orange-brown or brown, oval, filaments linear, ca. 0.6 mm in flowers with long styles, ca. 2 mm in flowers with short styles; stigmas 3, ca. 1.3 mm in flowers with long styles, ca. 0.5 mm in flowers with short styles; ovary superior, ovoid, trigonous, ca. 0.7×0.5 mm (diam.). Achene black or black-brown, broadly ovoid, trigonous, 3.5–6 mm, broadly ovoid fruit with reticulate surface, apex obtuse, base rounded, with a clearly projecting ridge, tightly enclosed by persistent perianth; persistent styles recurved, closely clinging to the fruit.

Distribution, habitat, and phenology. The known distribution area of *Fagopyrum qiangcai* is confined to the hillside of a dry river valley between Wenchuan and Li counties, Sichuan Province, China. Other wild species of buckwheat are rare in this area. The climate is extremely dry, and the soil is alkaline. Plants were observed in flower from July to October and in fruit from August to November.

IUCN Red List category. Although *Fagopyrum qiangcai* is restricted to Wenchuan and Li counties, we assess it here as Least Concern (LC) according to IUCN Red List criteria (IUCN, 2001), because of its relatively extensive distribution and the protected nature reserves in the areas in which it was collected.

Etymology. The indeclinable epithet of the new species is from the Pinyin and refers to the color of the leaves, with the veins bright red on young leaves and the adaxial leaf surfaces with white spots.

Karyotype. Ideograms of chromosomes at mitotic metaphase are shown for *Fagopyrum qiangcai* and *F. esculentum* Moench (Fig. 2E–H). The somatic chromosomes of *F. qiangcai* indicate that it is a diploid taxon, with a chromosome number of $2n = 2x = 16$; 12 chromosomes are metacentric, four chromosomes are submetacentric, and none are accompanied by satellites. The somatic chromosomes of *F. esculentum* show that this taxon is also diploid, with a chromosome number of $2n = 2x = 16$; all 16 chromosomes are metacentric and have no satellites. The karyotype of these two species can be classified as Stebbins's category 1A. Stebbins proposed that the evolutionary tendency of the karyotype in higher plants progressed from symmetry to asymmetry, suggesting that the species with a greater number of metacentric chromosomes evolved first (Stebbins, 1971). This theory would suggest that *F. qiangcai* evolved before *F. esculentum*.

Paratype. CHINA. Sichuan: ABA State, KeKu town, in thick growth of grass on slopes, 1580 m, 16 July 2006, J. R. Shao & D. Q. Bai Ghassot 4218 (SAU).

2. *Fagopyrum wenchuanense* J. R. Shao, sp. nov.

TYPE: China. Sichuan: ABA, Wenchuan Co., Mianchi, on low banks betw. fields, $30^{\circ}45' - 31^{\circ}43'N$, $102^{\circ}51' - 103^{\circ}44'E$, 1190 m, 16 Sep. 2006, J. R. Shao & D. Q. Bai Ghassot 4217 (holotype, SAU). Figure 3.

Species *Fagopyro gracilipedi* (Hemsl.) Dammer ex Diels affinis, sed ab eo plantis ramosissimis plerumque caespitosis, caulibus et ramis plerumque obliquis vel prostratis, foliis late cordatis vel ovatis usque longe hastatis, pedicellis basi pubescentibus, staminibus et pistillis inaequilongis atque acheniis ellipsoideo-triangulis vel late ovoideo-triangulis $3 - 3.5 \times 2.5 - 3$ mm differt.

Plants annual, herbaceous, 27–170 cm, multiple branching from basal or lower nodes; all nodes leafy; stems terete or nearly so, slender, usually obliquely positioned or prostrate, rarely erect, longitudinally lineate, green to green-brown or purple-brown, glabrous; internodes 1.5–7.6 cm. Leaf blades chartaceous, broadly cordate to ovate, ovate-hastate to triangular-hastate, or hastate to long hastate; leaves diminishing in size acropetally, $(1.3 -)2.1 - 6.5 \times 1.5 - 5.5$ cm; leaf apices acuminate to long acuminate to tail-like acuminate, base \pm cordate, occasionally deeply so, the 2 lateral blade segments usually larger, rounded; adaxial blade surfaces green or deep green, abaxial surfaces green or gray-green, sparsely puberulent on both surfaces; basal veins 7 to 9, lateral veins 6 to 11; petioles on lower leaves 2.2–5 cm, but diminishing apically, 0.5–2.2 cm, green, glabrate, sometimes puberulent and concave-grooved above, rounded or rounded-convex below; leaf sheaths semi-membranous, oblique, funnel-shaped, 3–6 mm, apex \pm acuminate to mucronate, with 5 to 11 small green veins. Inflorescences racemose, axillary and terminal, 1.7–14.5 cm; rachis slender, quadrate, green, glabrous, bracts sometimes present at middle nodes or higher; bracts leaflike, $1 - 1.3 \times 0.6 - 0.7$ cm, ovate, acuminate or mucronate; flowers arranged laxly, with internodes 0.3–2 cm apart, rachis ca. 4 mm diam. after flowering, floral bracts oblique, funnel-shaped, 2.3–3 mm, with 3 to 7 green veins, the middle vein extending as an apical mucro, 0.3–1 mm long, 3 to 5 florets subtended by each bract; pedicels linear, 2.5–5 mm, greenish or yellow-green, basally puberulent. Flowers with 5 perianth segments, these white, deeply dissected, and green at base, the midvein evident and included, lateral venation evident; stamens 8, unequal, arranged in 2 whorls, with 5 outside and 3 inside, filaments linear, 1–2 mm, glabrous, anthers elliptic, 0.2–0.3 cm, glabrous, purple-brown; pistil unequally long, the ovary ovate to trigonous, ca. 0.5 mm, styles 3, linear, glabrous, the stigma small, capitate. Capsules

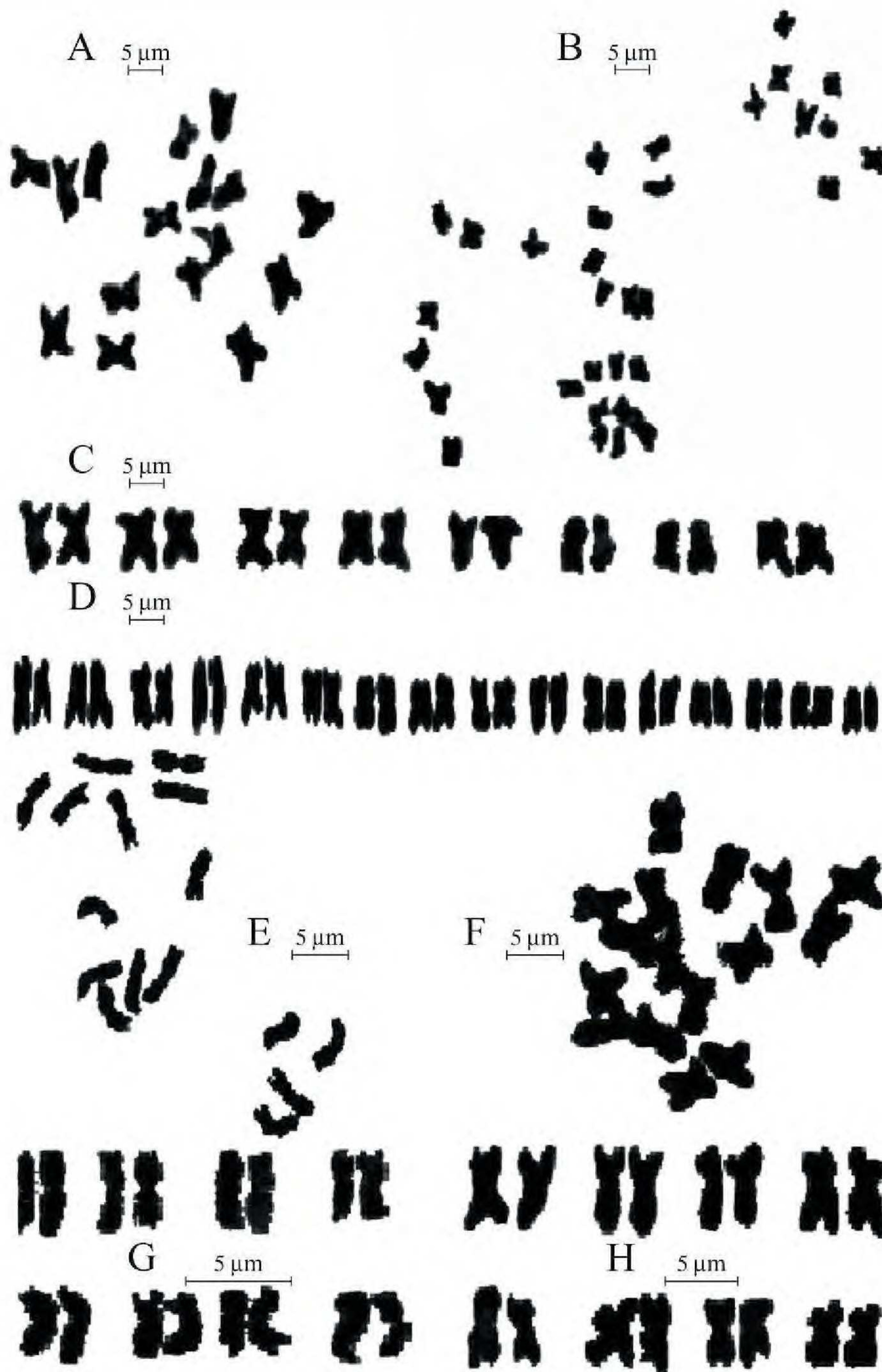


Figure 2. —A. *Fagopyrum wenchuanense* J. R. Shao, root tip cell chromosomes. —B. *F. gracilipes* (Hemsl.) Dammer ex Diels, root tip cell chromosomes. —C. *F. wenchuanense*, ideograms. —D. *F. gracilipes*, ideograms. —E. *F. qiangcai* D. Q. Bai, root tip cell chromosomes. —F. *F. esculentum* Moench, root tip cell chromosomes. —G. *F. qiangcai*, ideograms. —H. *F. esculentum*, ideograms. A, C from Bai Ghassot 4472; B, D from Bai Ghassot 4491; E, G from Bai Ghassot 4483; F, H from Bai Ghassot 4475 (all at SAU).

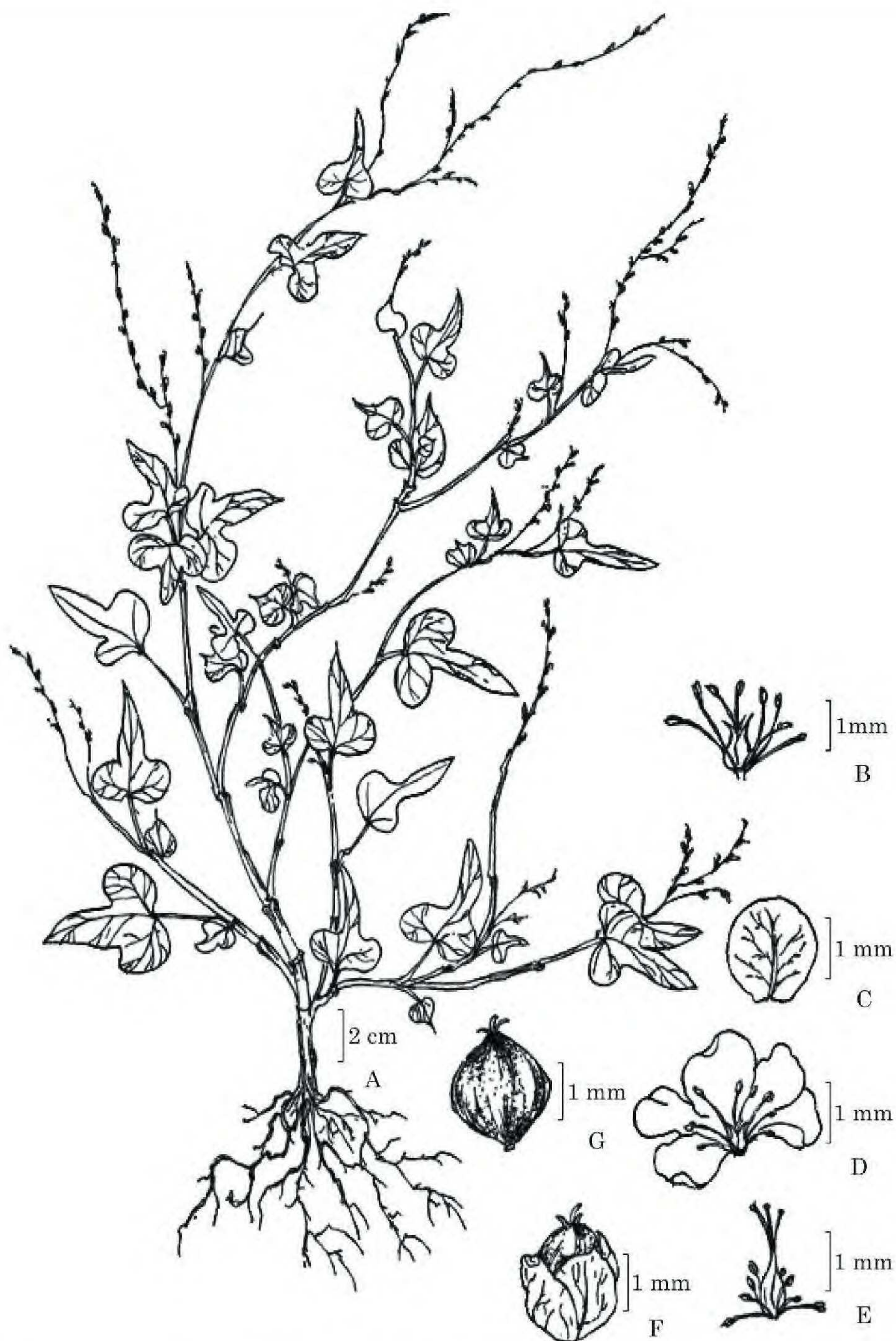


Figure 3. *Fagopyrum wenchuanense* J. R. Shao. —A. Plant habit. —B. Dissection of short-styled flower. —C. Perianth segment. —D. Intact flower with perianth segments remaining. —E. Dissection of long-styled flower. —F. Capsule enveloped by persistent perianth. —G. Capsule with perianth removed. A–G drawn by Wei Hou from the holotype, *J. R. Shao & D. Q. Bai Ghassot 4217* (SAU).

elliptic-triangular or broadly ovate-triangular, less often broadly ovate-rectangular or elliptic-rectangular, $3\text{--}3.5 \times 2.5\text{--}3$ mm, red-brown to black at maturity, perianths closely enveloping the fruit and persistent, styles persistent, recurved.

Distribution, habitat, and phenology. The known distribution area of *Fagopyrum wenchuanense* is confined to portions of Wenchuan County, Aba Prefecture, Sichuan Province, China. Plants were observed in flower from August to October and in fruit from September to November.

IUCN Red List category. Although *Fagopyrum wenchuanense* is restricted to Wenchuan County in Sichuan Province, China, we assess the new taxon here as Least Concern (LC) according to IUCN Red List criteria (IUCN, 2001). This is based on its relatively extensive distribution and the protected nature reserves in which it was collected.

Etymology. The specific epithet refers to the type locality of the new species in Wenchuan County, Sichuan Province, China.

Karyotype. Ideograms of chromosomes at mitotic metaphase are shown for *Fagopyrum wenchuanense* and *F. gracilipes* (Hemsl.) Dammer ex Diels (Fig. 2A–D). The somatic chromosomes of *F. wenchuanense* indicate that the species is a diploid taxon, with a chromosome number of $2n = 2x = 16$, and all 16 chromosomes are metacentric. The somatic chromosomes of *F. gracilipes*, on the other hand, show that it is tetraploid with a chromosome number of $4n = 4x = 32$, with 30 metacentric and two submetacentric chromosomes. Both species have no satellites. The

karyotype of these two species can be classified as Stebbins's category 1A (Stebbins, 1971).

Paratype. CHINA. **Sichuan:** Aba State, KeKu town, in thick growth of grass on slopes, 1580 m, 16 July 2006, J. R. Shao & D. Q. Bai Ghassot 4218 (SAU).

Acknowledgments. This research was supported by the Key Project of Science and Technology of Sichuan, China (grant no. 04NG001-015): "Protection and exploitation of wild-type buckwheat's germplasm resource." We are grateful to Wei Hou and Dan Yan for preparing the drawings.

Literature Cited

- IUCN. 2001. IUCN Red List Categories and Criteria, Version 3.1. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland, and Cambridge, United Kingdom.
- Li, A. R. 1998. Polygonaceae. Pp. 108–117 in A. J. Li (editor), *Flora Reipublicae Popularis Sinicae*, Vol. 25(1). Science Press, Beijing.
- Li, M. X. & R. Y. Chen. 1985. A suggestion on the standardization of karyotype analysis in plants. *J. Wuhan Bot. Res.* 3: 267–302.
- Ohnishi, O. 1998. Search for the wild ancestor of buckwheat. I. Description of new *Fagopyrum* (Polygonaceae) species and their distribution in China and the Himalayan hills. *Fagopyrum* 15: 18–28.
- Ohnishi, O. & Y. Yasui. 1998. Search for wild buckwheat species in high mountain regions of Yunnan and Sichuan provinces of China. *Fagopyrum* 15: 8–17.
- Stebbins, G. L. 1971. *Chromosomal Evolution in Higher Plants*. Edward Arnold Ltd., London.
- Wang, T. Y. 1989. Buckwheat germplasm resources in Tibet. Pp. 49–51 in T. Y. Wang (editor), *Collection of Scientific Treatises on Buckwheat in China* [ed. Chinese Buckwheat Research Assoc.]. Academic Journal Publishing Co., Beijing [in Chinese].